Energizing rural India using micro grids: The case of solar DC micro-grids in Uttar Pradesh State, India

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Electricity Situation in India

- India is one of the fastest growing economies;
- While 96% of the villages are electrified, around 300million people still without access;
  - 93% of total urban households are electrified
  - 67 % of total rural households have access
- In 2001, Government of India declared the objective of 'Power for All by 2012'; Now pushed to 2022
- Many of the households in grid connected villages do not take electricity connection
- Large number of hamlets continue to remain unelectrified
- Chronic shortage of electricity supply

The New Concept

- Discoms find grid extension economically unattractive to remote rural areas
- Discoms have also not attempted to electrify these areas with off-grid renewable energy systems
- MNRE/SREDA has attempted to address the vacuum to a large extent
- In addition, NGOs and entrepreneurs have implemented number of solar projects
- While implementation of AC mini-grids started since early Nineties, Solar DC micro grids seems to be the new concept finding favour to provide affordable electricity for basic services

Solar DC Micro-grids in India

- 1st solar DC micro-grid (5 kWp) was reportedly commissioned almost 30 years back in a small village in Uttar Pradesh

- *In 2010, Mera Gaon Power* (MGP) *piloted the DC micro-grid* technology in the *village Swuansi Khera* in Kanpur to provide LED based lighting

MGP has set up DC micro-grid in 900 villages covering around 20,000 households

- *In 2010*, another *pilot project* was initiated *by TERI* which served around *10 households in Jagdishpur district*, UP through DC micro-grid

TERI further set up 30 DC micro-grids in the six districts across UP connecting around 1400 households and shops;

Further expanded under Lighting a Billion Lives campaign connecting around 11000 households in 243 villages spread across 6 states

- UPNEDA developed a 1.2 kW DC micro-grid plant in the year 2011-12 in Mathia village in Gonda district to serve upto 200 households.

UPNEDA further expanded to set up 23 solar micro-grids in 11 districts (2011-12), covering around 4,000 families

Methodology

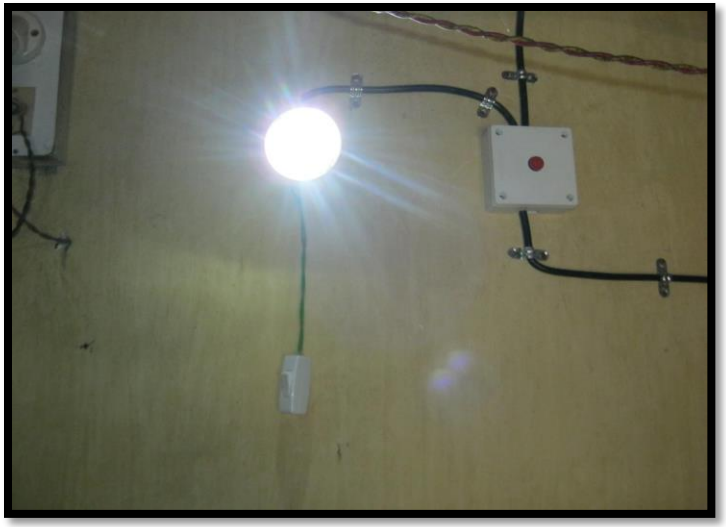
- *Objective*: Analyse the nuances of solar DC micro-grids in India, with a focus on Uttar Pradesh
  - Technical features, Service delivery, Financing, Tariffs, O&M, Impacts
- *Area of Study*: Districts where the DC micro-grids are in operation for more than one year
- *Sample size*: ~250 Households (Out of 2217 DC grid connections)
  - The households were randomly selected from 2-3 villages/hamlets of these districts
  - Primary Data collection through questionnaires

Type of Agency	District name	Villages	Households surveyed
NGO - TERI	Azamgarh	2	40
	Amethi	2	50
Government - UPNEDA	Siddharth anagar	3	38
	Hardoi	2	17
	Basti	2	15
Private - MGP & Minda	Sitapur	2	40
	Unaao	3	50

Technical features

MODEL	PLANT CAPACITY	HOURS OF SUPPLY	CONNECTIONS PROVIDED
UPNEDA	1.2kWp Supply voltage-24V	4-5	2 LEDs(2W & 1W, ~100 lumens), mobile charging point; Prepaid meter & timer
TERI	Different capacities Supply voltage-24V Different grid length	4-5	1-3 LED (3-6W, ~100 lumens), mobile charging point
MERA GAO POWER	240 Wp Supply voltage-24V Shorter grid length	5-7	2 LEDs (1W each, ~75 lumens), mobile charging point
MINDA	240 Wp Supply voltage-24V	4-5	2 LEDs (1.5W each, ~100 lumens)

Glimpses



Service delivery

UPNEDA	TERI	MERA GAO POWER	MINDA
• Built, Operated and Maintained by UPNEDA • Technology providers install the system • Local operators are paid salaries to operate the system • Monitoring by UPNEDA	• TERI motivates local youth to become Energy Entrepreneurs (EE) to invest s in micro-grids • Assists in procurement and installation of system • Trains EE's to operate and maintain it	• Design, installation, operation, maintenance – • A micro utility approach • Collect connection fee and prepaid weekly tariffs • Form JLG's to ensure regularity in tariff payment	• Minda installed the system • Hands it over to rural entrepreneurs after training them • Operation, maintenance and revenue collection done by local entrepreneurs

Finance mechanism

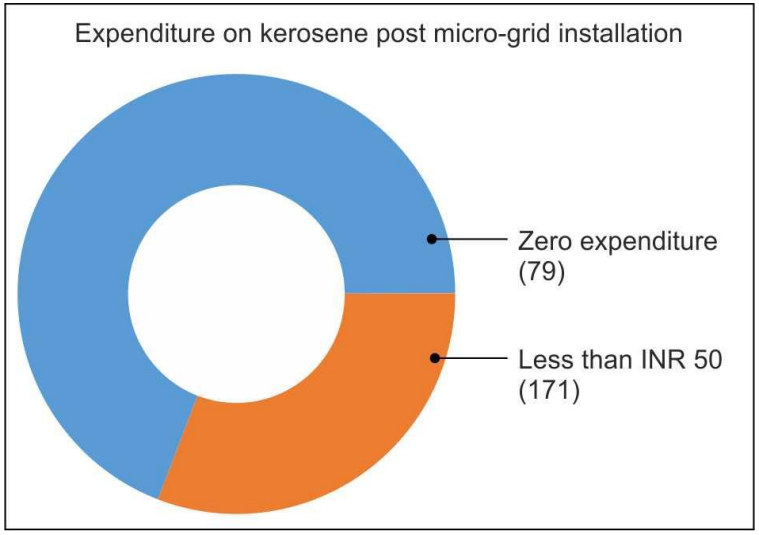
UPNEDA	TERI	MERA GAO POWER	MINDA
• Capital subsidy of 30% by MNRE • Remaining 70% borne by UPNEDA • TARIFF: INR 150 per month	• 60% TERI subsidy + 40% EE investment • **Micro-grids under NFA**: 45% of capital cost shared by EE & bank or wholly by EE + 55% TERI subsidy • TARIFF: INR 5/household/day	• Initial investment by MGP • Partially supported by grants from different agencies • TARIFF: Connection fee- INR 50 and weekly tariff of INR 25	• MNRE provided 30% of the project cost as subsidy • Remaining 70% invested by local entrepreneurs • TARIFF: INR 100 per month

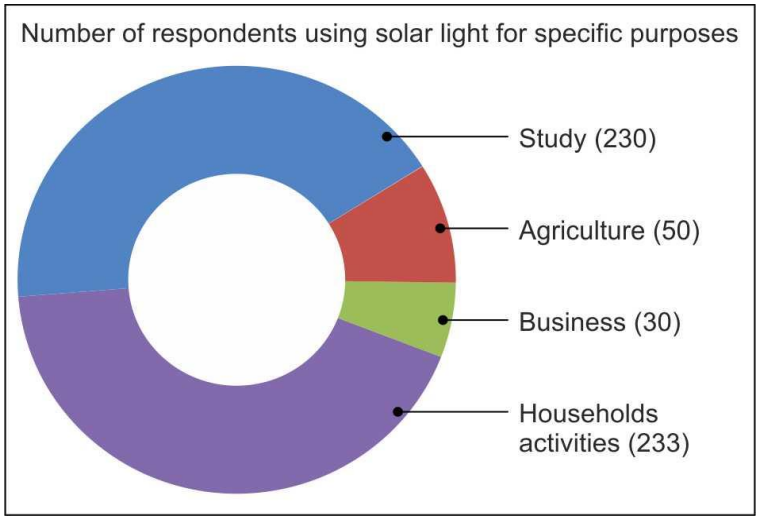
Installation cost ranges between Rs 2200/HH to Rs 4000/HH, depending on technical features

Operation and Maintenance

UPNEDA	TERI	MERA GAO POWER	MINDA
• Local person deployed for operation, maintenance and collection of monthly tariff • Battery replacement to be done by UPNEDA • Plants are partially operating with some faults	• EE's responsible for operation and maintenance • Formal training given by TERI • Battery replacement expected by EEs • Operating without faults	• MGP team takes care of preventive and breakdown maintenance • Battery replacement to be done by MGP • Operating without faults	• EE's responsible for operation and maintenance • Formally trained for operation and maintenance activities • Operating without faults

Project Impacts





- Fuel cost on kerosene reduced from Rs 80-150 to nil for 68.4% users and less than INR 50 for 31.6% households
- Increased study hours (from 1 hour to 2 hours)
- Reduction in health issues faced by women
- 94.4% found the solar light quality very good; Remaining 5.6% reported satisfaction

Conclusion

- With large number of un-electrified hamlets, potential market for both AC and DC micro-grids in India is huge
- DC micro-grids can provide a reliable, efficient and sustainable electricity supply at a lower cost with greater effectiveness.
- The DC micro-grid is more flexible and accommodating of the load
- Micro-grids provides good prospects for private sector and social enterprises and serve large number of population
- However, these startups' prospects might be extinguished in a moment if regular power lines marched into these hamlets without any exit strategy for these micro grids
- With advent of new interconnection technologies and more clarity on the policy front, the micro-grid and the regular power grid might can possibly co-exist and complement each other, making the village's power supply cleaner and more robust.